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SANITATION OF THE CROTON WATERSHED[1]

By T. D. L. Coffin

The Croton watershed, covering 375 square miles principally in northern Westchester and Putnam Counties, New York, supplies part of the water consumed in the Boroughs of Manhattan and The Bronx, New York City. From it, there is a present daily draft of 350,000,000 gallons. The storage capacity of the various reservoirs within the watershed is 104,000,000,000 gallons, or about 280 days' supply under the present draft. This long storage is an important element in securing a surface water of low bacterial content.

Within the watershed there is a population of about 25,000; there is one community of 3000, another of 1500, a third of 1200; four between 500 and 1000; 16 of 100 to 500, and 22 named communities with a population under 100. The remainder of the population, or about 13,000, are rural residents.

As a portion of the watersheds division of the bureau of water supply, an organization devoted to the sanitation of the watershed is maintained. It is composed of two engineering assistants, one typist, 21 inspectors under the immediate direction of a chief inspector, one machinist, one autobomile engineman, and eight laborers. As required, additional laborers assigned elsewhere in the division are temporarily detailed to sanitation.

Inspection. For its sanitary patrol the watershed has been divided into 21 districts, to each of which a watershed inspector is assigned. In the boundaries of these districts consideration was given to the proximity of aqueduct intakes, population, popularity of the lakes for outing and fishing parties, length and number of tributary streams, length of lake margins and similar features. Each inspection district is further divided into a number of patrol routes, and once each month a patrol schedule is prepared indicating the patrol route for each inspector for each day of the month. In this way it is known that the entire watershed is covered at proper intervals and an excellent check is had upon the inspectors. In covering these routes the inspectors note any new condition likely to cause contamination, any change of a previously reported violation or nuisance, new building construction of any sort, make inquiries as to cases of typhoid fever, dysentery or poliomyelitis, use disinfectants where necessary, insure that boats are kept in a cleanly condition, prevent bathing in reservoirs, use algaecides where required in small amounts, and post trespass signs upon the city property margins. The men assigned to this work are considerably above ordinary laborers in intelligence, are per annum employees, work each day of the year excepting for a two weeks vacation, and will shortly appear in uniform.

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[1] Read at a meeting of the New York Section, December 20, 1916 and illustrated with lantern slides of the several structures mentioned.

This work of sanitary inspection was begun about 1888, and in 1892, during the administration of Mayor Gilroy, Commissioner Michael T. Dailey ordered a general clean-up of the watershed. Thousands of dollars were spent at this time resulting in the destruction or removal of many dwellings, stables, privies, slaughter houses and drains located in close proximity to streams. At this time the first community disposal system in the watershed was constructed when a portion of the village of Brewster was sewered. The sewage so collected was treated with electrozone by the Wolff process, previous to absorption in the soil. The electrozone plant was continued in service until destroyed by fire in 1911.

Our present records, probably begun in 1897, indicate that over 3200 violations of the rules of the State Department of Health have been discovered, of which 124 are unabated. These, of course, are receiving active attention looking to their early correction.

Commencing November, 1913, the inspectors were notified to report the conditions of premises upon which buildings were about to be erected in locations such that contamination might result. In all such cases, numbering 320 to date, appropriate letters have been sent to the owners, together with a copy of the rules of the state department of health, so that at the time of construction proper means for the disposal of all wastes might be provided. This has worked out very satisfactorily and it is found that owners approached in this way are generally ready to consider the city's interest in the premises.

Typhoid fever. The department is particularly concerned that proper precautions be taken in all typhoid fever cases occurring within its watershed. With few exceptions, cordial relations exist between its employees and physicians practising within the watershed so that physicians usually inform the local inspectors of all suspected cases. In rural communities news travels rapidly so that inspectors, for the most part long resident within their districts, secure their first information by hearsay should the physician fail to give notice. During one year the department checked its cases against those reported by law by the local health officers to the state department of health and failed to find that local cases had escaped our earlier attention, so that there is good reason for believing that our records show all the cases occurring within the watershed.

Upon first notice of a suspected case, a careful examination of the premises is made to insure that all dejecta are cared for in such manner as to be harmless; the history of the case is obtained to learn, if possible, the source of infection; disinfectants are supplied to be used under the direction of the physician; samples of water and milk are analyzed; specimens from the patient are taken and returns made to the attending physician. If the case proves positive, the premises are frequently inspected to make certain that the nurse or other attendant is continuing necessary precautionary measures, immunizing material is furnished the physician whenever he can persuade the other members of the family to accept treatment. After convalescence, feces samples are taken some ten days after the patient's temperature becomes normal and at ten-day intervals until two successive negative returns are obtained. Until such returns are received, the local physicians will usually require the patient to remain isolated.

Our records indicate the following cases of typhoid fever annually within the watershed beginning 1910: 23, 22, 17, 9, 19, 12 and 3 to October 1 of the current year. There have been many suspected cases to which considerable preliminary attention has been given, but the diagnosis has proved negative.

Dead animals. Presumably no more animals die upon this watershed than upon a similar area elsewhere, yet the yearly total of animals whose burial is looked after by this department is surprising. For instance, during 1915, the following dead animals found within pollutable distance of a reservoir or stream were properly disposed of under direction of the sanitary force:

Large domestic animals	303
Small domestic animals	247
Wild animals	367
Fish	11,890
Total	12,807

Copper sulphate. Owing to the large area of shallow flowage in the reservoirs, microscopic organisms objectionable for the tastes, colors, and odors they produce are prevalent and to hold these growths in check copper sulphate is used. This material is dissolved in the usual manner by trailing it in bags behind a boat. For treating large areas of deep water in Croton Lake, a motor launch is available and capable of distributing about 1000 to 1500 pounds of chemical in eight hours. Shallow areas and all secondary reservoirs are treated either with row boats or boats fitted with detachable motors, of which two are available. Row boats will distribute 300 to 500 pounds of copper sulphate per day of eight hours and those fitted with detachable motors about twice this amount. In treating a reservoir, a map of it is first divided into a number of smaller areas by drawing lines from prominent land marks and the area of each section determined by planimeter. The weight of the water in each sub-division is then determined, it being assumed for this purpose, that all water 10 or more feet below the surface requires no treatment, and from this the amount of copper sulphate to be used is determined. The usual dilution is 1:3,000,000 to 1:5,000,000, depending upon the organism present. The boatmen are instructed as to landmarks and the treatment is made as evenly as possible over the area in question. Often it is noted that only small bays or coves are affected, in which event a local application is made. In some cases the area affected is so slight that the treatment may be made from shore, the bag of sulphate being trailed from a pole. It is believed that these partial treatments are very necessary to prevent the growth spreading over the entire water surface. Last year about 15,000 pounds of copper sulphate was required and the year before 30,000 pounds.

Dunwoodie chlorination plant. All the water delivered to the city through the old and new aqueducts is chlorinated at a plant located at Dunwoodie, Yonkers, New York. This plant is now of a dual type, it being possible to treat the flow with either "bleach" or liquid chlorine. The latter treatment is at present in use and will be continued, barring accident, unless a change in the market renders the bleach treatment of less cost. This plant was described in detail in *Engineering News,* February 27, 1913, and September 7, 1916.

Sewage treatment plants. At Mt. Kisco, N. Y., the City of New York has built and operates a sewage disposal plant treating the sewage of that village. It comprises settling tank, contact beds, sand filters and a disinfecting plant. The village built and maintains the lateral and trunk sewers.

At Brewster, New York, a portion of the village is sewered and the sewage so collected, amounting to some 10,000 gallons daily, is chlorinated and conducted to a settling basin and tile field. It is realized that this arrangement is somewhat peculiar in that the use of chlorine previous to settling lessens materially the hydrolitic action that would materially lessen the amount of solids, and, perhaps, even lessens the oxidizing process that might be expected to occur in the tile field, but the topography is such that it was necessary to parallel a reservoir margin for a distance of about two miles with the sewer line to reach an area available for a disposal field and to avoid the possibility of introducing raw sewage into this reservoir through mischance with the sewer, the unusual arrangement was decided upon. Owing also to this location of the sewer, enough chlorine is used to insure a sterile sewage, requiring 400 parts per million.

Kisco River chlorinating plant. Kisco River is the largest affluent of Croton Lake, discharging into that body of water without having passed through a reservoir. It receives all the street wash of the village of Mt. Kisco and the effluent of the disposal plant for this village. For these reasons, the waters of this stream have been continuously chlorinated since 1911, when a bleach plant was first placed in operation. At the present time, a gas plant is being constructed to take its place. The construction is such that a portion of the river flow, 50,000 gallons per day or more, may be diverted from the river channel into a chlorinating well with its bottom 6 feet below the river bed. Dry feed, manual control chlorinators will deliver chlorine to diffusers located at the bottom of this well, and this chlorine solution will then be returned to the river, there to mix with the regular flow.

Katonah chlorinating plant. The greater part of the street wash and yard runoff from premises in Katonah enters directly into Croton Lake through a small stream known as Katonah brook. To insure against danger in this quarter, the department operates a chlorinating station on this stream. This is a bleach plant and embodies no unusual features. A duplicate plant is located at the outlet of Lake Gleneida, which in part is subject to street drainage. This plant is operated part time only.

Tonetta Brook. As a part of the plant already mentioned as treating the sewage of Brewster, provision is made for chlorinating the flow of Tonetta stream before it enters the diverting reservoir. This is a bleach plant built in 1911, replacing an electrozone plant which burned to the ground that year. It is of interest that the cypress solution tanks are still in a watertight condition after five years of continuous service. After erection the tanks were given an interior coating of cement plaster on metal fabric and were then painted inside and out with a coat of minwax.

Upon Charter Brook, another stream flowing through the village of Brewster, a sedimentation basin and sand filter have been provided. Except after exceptionally heavy or protracted storms there is no overflow from these beds and it is hoped that a chlorinating plant may be installed soon to treat such overflow.

At Purdy's Station a small filter basin has been constructed through which the road wash of this community must pass before entering Croton Lake.

Institutional sewage treatment. In addition to the plants operated by the city, there are in the watershed several institutional sewage disposal plants, oversight of which is exercised by the department.

At the Montefiore Home, Bedford Hills, New York, the sewage is disposed of in a plant consisting of septic tanks, dosing chambers, sprinkling filters, the effluent of which is chlorinated and run out into a series of trenches following the contours of a hillside. The chlorinating apparatus is a recent addition to the plant originally installed after plans prepared by Messrs. Hering and Fuller. The inmates at this institution average about 200 and the daily water consumption varies from 20,000 to 30,000 gallons daily.

At the Bureau of Social Hygiene, Bedford Hills, New York, there is a sewage disposal plant designed to handle the sewage from 100 persons and consisting of Imhoff tank, dosing chamber and tile field, divided into four sections and located in a natural sand basin from which there is no surface outlet.

At the New York State Reformatory for Women at Bedford Hills, N. Y., the sewage from 600 persons is cared for in a plant first operated January 11, 1916, plans of which were prepared by the state architect. The plant includes a screen chamber, three Imhoff tanks, sludge bed, eight sand filters, chlorine gas machine and appurtenances.

At the Lincolndale Agricultural School, Lincolndale, New York, a plant treats the sewage from about 250 persons. This plant, designed by N. S. Hill, consists of septic tanks, dosing tanks, contact beds and sand filters, the effluent of which is chlorinated by the use of bleach.

At the Waccabuc Inn, Lake Waccabuc, New York, a plant designed by Lederle and Provost treats the sewage from a summer hotel population by sedimentation, filtration and chlorination.

At the Mountain Spring Farm, Brewster, New York, a plant designed and constructed by the New York Sewage Disposal Company treats the sewage derived from a sanitarium of about 50 inmates. This plant comprises a septic tank, sand filters and an irrigation field.

At Carmel, upon New York the premises of Ryder Brothers, there is a plant treating the sewage derived from 40 to 50 persons. The arrangement of the tile field at this plant is of interest in that the tile runs, each 200 feet in length, follow a contour of a steep hillside. At the middle of each tile run there is a diverting unit, a small concrete box with an inlet near the top and an outlet at the bottom. Between the inlet and outlet pipes there is a movable stop plank which, when in place, allows the sewage to rise and flow into the tile line. Any flow in excess of the capacity of the particular run passes over the stop plank to the next lower diverting unit. By raising the stop plank all sewage passes into a lower unit and opportunity is afforded for the drying out of the soil about a used tile run.

In addition to the larger plants described above, there are numerous smaller plants scattered about the watershed serving single residences, hotels and homes. These generally are of the septic tank, siphon chamber, tile field type. In one case the discharge from the siphon chamber is sprayed onto a rocky hill. The premises, however, are occupied only during the summer months. In two instances modified Imhoff tanks replace the ordinary single story settling tank. The tendency in single story settling tanks is toward a baffled rather deep narrow tank, having an area of about 2 square feet per person served, and away from a circular tank of brick, as affording a more uniform flow. In several instances these tanks have sloping bottoms with piping for blowing out the sludge at intervals.

Many styles of tile are used in the absorption fields; some of the more expensive are rectangular in shape and divided into several compartments. Some designs employ a two or three-way gate for diverting the sewage from one to another portion of the tile field while others use a specially designed Y tile with a ridge extending along a portion of the invert so that a siphon discharge is divided among several runs of tile, this method sometimes being employed when the tile runs are upon a hillside. It is not known that any particular shape of tile has a distinct advantage over the plain round glazed drain tile, without bell or collar, when these are laid in a field with provision for frequent rest periods. The length of tile per person varies with the character of the soil and the designer of the system but probably averages from 25 to 40 feet per person. They are laid upon a very flat grade.